Robotic Localization using Shadow Information in Imagery

Completed Technology Project (2011 - 2015)

Project Introduction

My overall research goal is to enable a new capability to rendezvous and dock autonomously with an aggressively tumbling target (e.g. disabled satellite or space debris) for which we have little or no a priori information. In particular, my aim is to enable this new capability for small satellite missions. While focusing on small satellite missions imposes restrictions on sensing and computational resources, it will drive my research toward developing robust and affordable solutions to enable this critical technology. Furthermore, I believe that the results of this work for small satellite missions will be extensible to larger missions, and will thus leverage the affordability of in situ testing on small missions before implementation of the technology on larger missions. My approach is to develop and demonstrate a framework for fusing feature-based (i.e. vision) and range-based (i.e. LIDAR) simultaneous localization and mapping (SLAM) techniques in a real-time framework that will enable estimating both the shape of a target (i.e. reconstruction) and its pose relative to the servicing satellite. Robustness will be achieved by exploiting the complementary strengths of each sensing approach. This approach significantly extends work in the Stanford Aerospace Robotics Laboratory (ARL) in feature-based and range-based target reconstruction and relative pose estimation for autonomous rendezvous. The ARL has a rich history in controls and estimation research applied to robotic systems, with recent successes that lay a solid foundation for my proposed work. Further, my approach will involve experimental demonstrations on existing ARL hardware platforms, with no additional (major) equipment required. This proposed research addresses several of the Robotics, Tele-Robotics and Autonomous Systems (Technology Area 04) Technical Areas as outlined in "TABS_NSTRF_FY11.pdf". These areas include: Autonomous Rendezvous and Capture (4.6.1), Simultaneous Localization and Mapping (4.2.1), Stereo Vision (4.1.1), LIDAR (4.1.2), and Proximity Sensing (4.1.3). Furthermore, this new capability will be critical to the development of an effective, affordable, and robust solution to the NASA Grand Challenge of Space Debris Hazard Mitigation, especially for safe mitigation of man-made orbital debris.

Anticipated Benefits

This new capability will be critical to the development of an effective, affordable, and robust solution to the NASA Grand Challenge of Space Debris Hazard Mitigation, especially for safe mitigation of man-made orbital debris.

Project Image Robust Sensing for Rendezvous and Docking: Fusion of Vision and LIDAR in a SLAM Framework

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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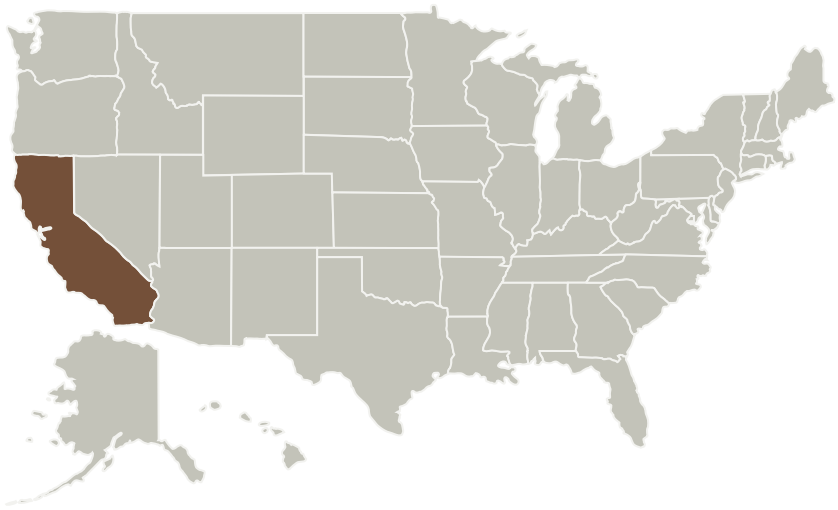
Primary U.S. Work Locations and Key Partners



Primary U.S. Work Locations
California

Images

4722-1363264100012.jpg
Project Image Robust Sensing for Rendezvous and Docking: Fusion of Vision and LIDAR in a SLAM Framework
(https://techport.nasa.gov/image/1817)

Project Management

Program Director:
Claudia M Meyer

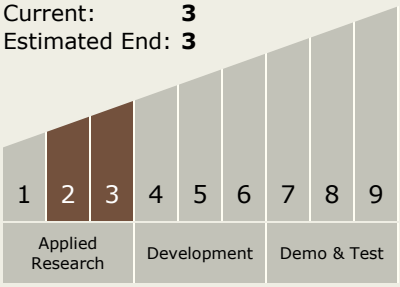
Program Manager:
Hung D Nguyen

Principal Investigator:
Steve Rock

Co-Investigator:
Jose A Padial

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.5 Autonomous Rendezvous and Docking
    - TX04.5.7 Modeling, Simulation, Analysis, and Test of Rendezvous, Proximity Operations, and Capture

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Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html